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A1_8 Special Relativistic Considerations of the New York Minute

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Abstract

In this paper, we investigate the special relativistic affects of New York having a 58 second minute compared to the 60 seconds we observe. We found that the city of New York must be moving at $v \approx 7.68 \times 10^7$ m s^{-1} relative to the rest frame of Earth if this time difference is due to time dilation. We also found that the true average male New Yorker height is 184.14 cm compared to the average height we observe of 178 cm due to length contraction. This increases the probability of a male New Yorker being taller than the average Dutch male from 0.29 in our rest frame to 0.58 in the New Yorker rest frame.

Introduction

The idiom 'New York minute' describes a very short period of time, with it referring to the tendency for time to run faster in New York [1]. A recent article claims that New York City has officially adopted 58 seconds as a New York minute [2]. This difference might be able to be explained by the special relativistic effects of time dilation. We aimed to quantify some of the consequences for New York City if this 2 second difference is a product of special relativity.

Theory

Firstly, we considered the rest frames of Earth and of New York. We can relate the time we observe (t') to the time experienced in New York (t) using,

$$t' = \gamma t, \tag{1}$$

Where γ is the Lorenz factor. Given that,

$$\gamma = \frac{1}{\sqrt{1 - v^2/c^2}} = t'/t, \tag{2}$$

where v is velocity and c is the speed of light, we can rearrange equation (1) for v:

$$v = \sqrt{c^2 - (t/t')^2 c^2}. \tag{3}$$

We can therefore find the velocity of New York relative to our rest frame. From this, we then consider the effect of length contraction on male citizens observed in New York, as their true height will be taller than we observe due to length contraction if this velocity is perpendicular to the New York plane. Length contraction is given as,

$$L' = L/\gamma, \tag{4}$$

where L' is the average height we observe and L is the true average height of New Yorkers. We can then compare this value to the average height of the country with the tallest people in the world, the Netherlands [3]. Considering that height is roughly a normal distribution [4], we can plot the distribution of New Yorker heights we observe compared to the true distribution of

New Yorker heights using,

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}, \tag{5}$$

where μ is the average height and σ is the standard deviation [5].

Results

Considering that we observe 60 s (t') for every 58 s that passes in New York (t) in this scenario, substituting this into equations (2) and (3) gives a Lorenz factor of $\gamma \approx 1.04$ and a velocity for New York of $v \approx 7.68 \times 10^7$ m s^{-1} relative to the rest of Earth. Assuming that male New Yorkers share the same average height with men from the USA of roughly 178 cm [6], we can find the true average height of New York men from equation (4) to be roughly 184.14 cm. Assuming the standard deviation for height of American men is roughly 8 cm [6], this allows us to plot normal distributions for observed male New Yorker height and true male New Yorker height using equation (5), and compare that to the average Dutch male height of 182.53 cm [3], producing Figure 1.

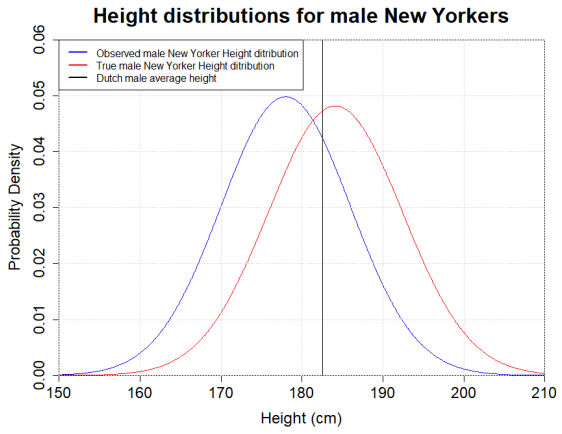

Figure 1: R Plot showing how the observed male New Yorker height distribution compares to the true male New Yorker height distribution. By using the pnorm function in R code, we found probabilities of a male New Yorker being observed to be taller than the average Dutch male of about 0.29 while the probability of a male New Yorker being taller than the average Dutch male in their frame being roughly 0.58.

Discussion and Conclusions

The velocity of New York City relative to the rest of Earth was found to be $v \approx 7.68 \times 10^7$ m s^{-1}. Since New York city isn't moving upwards, we can assume this velocity must be rotational. Considering the largest possible rotational velocity of Earth at the equator is roughly 460 m s^{-1} [7], this implies that New York is moving roughly 167×10^3 times faster than the fastest possible Earth rotational velocity, which is obviously impossible. Therefore, New York likely experiences time the same as us, but simply defines a minute as 58 s rather than 60 s [2], rather than it being a consequence of special relativity.

In conclusion, we found that the velocity required for New York city to experience 58 s compared to our observed 60 s is $v \approx 7.68 \times 10^7$ m s^{-1}, and that we observe the probability of a male New Yorker being taller than the average Dutch male of 0.29, while the probability in the New York frame is 0.58. The comparison between New York's velocity and Earth's maximum rotational velocity however indicates that the 58 s New York minute is not a product of special relativity.

References

[1] `https://bit.ly/33akOJE` [Accessed 20 November 2019]

[2] `https://bit.ly/2KHIv5X` [Accessed 20 November 2019]

[3] `https://bit.ly/2QzIZyG` [Accessed 21 November 2019]

[4] `https://bit.ly/37mCjtz` [Accessed 21 November 2019]

[5] `https://bit.ly/37A4XYu` [Accessed 21 November 2019]

[6] `https://bit.ly/35qGqmP` [Accessed 21 November 2019]

[7] `https://bit.ly/2O6Q9IS` [Accessed 21 November 2019]